Tobacco Waste to Water Pollution: Nicotine and Cotinine Persistence in Protected Northern Mission Bay Wetlands

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Background

- Stormwater runoff originating in the Pacific Beach neighborhood of San Diego flows into the adjacent Kendall-Frost Mission Bay Marsh Reserve through the Noyes St. outlet and the Olney St. outlet.
- Cigarette butts, the most littered item in the world, are a pervasive source of pollution in the environment. As they degrade, they release many environmental hazards, including nicotine, cotinine, heavy metals, microplastics, pesticide chemicals and more.[3]
- Previous research detected nicotine and cotinine in the reserve, suggesting stormwater runoff could be a contributor to tobacco-related pollution in the Reserve.[1]

Our Goal

To further investigate the relationship between disposal of commercial tobacco products in the drainage area of Pacific Beach and water concentration of nicotine and cotinine near the Noyes St. and Olney St. stormwater outlets in Kendall-Frost Mission Bay Marsh Reserve. (See **Fig 1** for area map)

Methods

- A repeated measures design was used to collect 6 rounds of tobacco product waste data[2] and 4 rounds of soil and water samples timed after rain events.
- A total of 24 water samples were collected near the Noyes and Olney St. drainage outlets on four collection dates: January 24th, January 30th, February 15th, and March 7th.
- Water samples were analyzed at the SDSU Environmental Chemistry Laboratory under the supervision of Dr. Eunha Hoh using liquid chromatography-tandem mass spectrometry to measure nicotine and cotinine concentrations.

**For more information on tobacco product waste data and reaccumulation, please see the poster: Why Cleanups Do Not Work: Accumulation and Re-accumulation of Cigarette Butts on Runoff-Contributing Surfaces Near Storm Water Inlets.*

Pacific Beach stormwater runoff carries **nicotine and cotinine** from tobacco product waste into the **protected wetlands** of Mission Bay.

Dilution effect supports urban runoff as source of tobacco pollution.

Nicotine and cotinine levels were higher near the Noyes St outlet, where ocean water from Mission Bay cannot flush the area and dilute runoff.

5 - 6 times higher nicotine levels

were found in water samples taken near the Noyes St outlet.

Nicotine levels remained relatively stable despite rain & cleanups.

Light rainfall and multiple rounds of tobacco product waste cleanups appeared to have little effect on nicotine levels in the Reserve.

After rain events, cotinine **decreased** near Noyes St. and **increased** at the Olney St outlet.

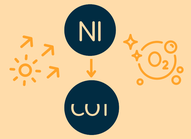
Figure 1. Wetlands Study Area Map



Sampling Sites: Stormwater Outlets at Noyes and Olney Streets

Dilution, contamination, & oxidation could explain cotinine patterns.

The contrasting responses to rainfall between sites suggest only some cotinine in the Reserve originates from stormwater runoff. Other potential sources could include the oxidation of nicotine into cotinine in the Reserve and wastewater leakage.



Noyes St. Outlet

In the beginning of the season, a high level of nicotine was trapped without access to "clean" ocean water. More nicotine could result in more cotinine produced as nicotine oxidized. As rainfall increased runoff, water with comparatively less cotinine was introduced, lowering concentration.

Olney St. Outlet

The reverse effect occurs, with ocean water likely diluting nicotine levels in the beginning of the season. Post-rain increases in runoff introduced water with comparatively more cotinine, increasing overall concentration.

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References

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2. Matt, G. E., Greiner, L., Vingiello, M., Wooldridge, G., Tran, K., & Novotny, T. E. (2026). Why Cleanups Do Not Work: Accumulation and Reaccumulation of Cigarette Butts on Runoff-Contributing Surfaces near Storm Water Inlets. ACS ES&T Water.
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Results

Nicotine

Nicotine was detected in all 24 water samples collected from January 24 to March 7, 2025. **(See Fig 2)**

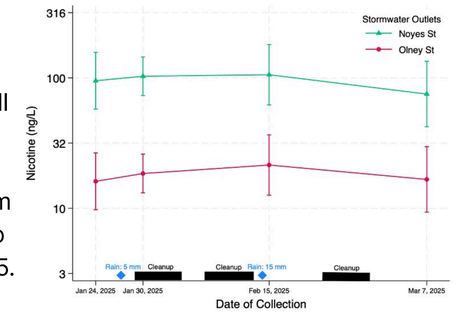

Figure 2. Nicotine concentration in water at the Noyes and Olney St. outlets.

Average concentrations ranged from 80 nanograms (ng) to 110 ng per liter (L) of water at the Noyes outlet and 15-21 ng/L at the Olney St outlet.

Cotinine

Cotinine was detected in all 24 water samples collected from Jan 24 to March 7, 2025. **(See Fig 3)**

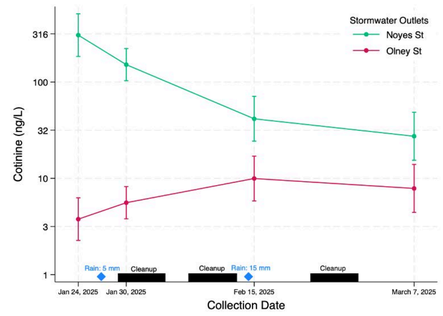

Figure 3. Cotinine concentration in water at the Noyes and Olney St. outlets.

Concentrations ranged from 26-306 ng/L at the Noyes outlet and from 3-9 ng/L at the Olney St outlet.

Conclusion

- The continued presence of nicotine and cotinine in the Kendall-Frost Mission Bay Marsh Reserve indicates that the use and disposal of tobacco products are polluting the protected wetlands with toxic chemicals.
- Lower levels of nicotine and cotinine at the Onley St. location indicate that ocean water from Mission Bay provides a "flushing" effect, which lowers pollutant concentration.
- Stable nicotine levels, despite rainfall and tobacco product waste cleanups in the drainage area, indicate that it is a persistent pollutant in the Reserve.
- Differing cotinine concentration patterns in the two sites suggest that while some portion of the cotinine originates in the stormwater system, some cotinine contamination results from sources such as nicotine oxidation from Reserve organisms and/or wastewater leakage into the Reserve with human sources of this nicotine metabolite.
- Further research is needed to confirm alternative sources of cotinine, which would impact strategies for preventing pollution in the Reserve.

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